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EUROPEAN UNION

ACTION FOR LIVELIHOOD ENHANCEMENT IN NORTHERN UGANDA (ALENU)

SOYBEAN PRODUCTION TRAINING MANUAL

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CARITAS Schweiz Suisse Svizzera Svizra

Advance AFRIKA Where Dignity Matters

AFARD The Quest for A Better Society

GWED-G Gulu Women's Economic Development & Globalization

ACKNOWLEDGEMENTS AND **DISCLAIMER**

This manual was developed by Pascale Waelti of Bern University of Applied Sciences, School of Agricultural, Forest and Food Sciences HAFL and Robert Bakyalire of AFARD for a consortium consisting of four NGOs (Caritas Switzerland, Advance Afrika, Agency for Accelerated Regional Development, and Gulu Women Economic Development and Globalization) for the implementation of the Action for Livelihood Enhancement in Northern Uganda (ALENU) Project that is funded under the Development Initiative for Northern Uganda (DINU), a government of Uganda programme supported by the European Union (EU) and supervised by Office of the Prime Minister.

The manual formulation process included a review of a number of manuals for which we are indebted, namely:

- Infonet Biovision website: https://infonet-biovision.org/
- Agrodok - Cultivation of Soy beans

Pictures and text extract of these sources have been used in this manual.

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ALENU PROJECT

Under the Development Initiative for Northern Uganda (DINU), a Government of Uganda programme supported by the European Union (EU) and supervised by Office of the Prime Minister, Caritas Switzerland has received a grant to implement the Action for Livelihood Enhancement in Northern Uganda (ALENU). ALENU is implemented by a consortium consisting of four NGOs (Caritas Switzerland, Advance Afrika, Agency for Accelerated Regional Development, and Gulu Women Economic Development and Globalization).

Objectives and Results

ALENU is a 40-month action that focuses on improving livelihoods through increased and diversified food production, enhanced market opportunities and better maternal and child nutrition in six districts of the West Nile and Acholi sub-regions. Its overall objective is, "to consolidate stability in Northern Uganda, eradicate poverty and under-nutrition and strengthen the foundations for sustainable and inclusive socio-economic development." And the specific objective: is, "to increase food security, improve maternal and child nutrition, and enhance household incomes through support to diversified food production and commercial agriculture and through improving household resilience (notably to climate change) and women empowerment. The three main result areas are: Result 1.1: Increased production of diversified food; Result 1.2: Increased market accessibility; and Result 1.3: Improved nutritional status

Districts and Sub Counties

Agago (Wol and Lokole); Amuru (Amuru and Lamogi); Omoro (Odek and Lakwana); Nebbi (Erussi and Atego); Pakwach (Pakwach and Panyimur); Zombo (Kango and Athuma)

Main Activities

Result 1.1: Increased production of diversified food
Select HHs; develop Family Development Plans; develop seasonal Production and Marketing Plans; set up group demonstration gardens; conduct farmer field school sessions; facilitate outreaches by local government extension staff; organize seasonal agro-input fairs; build capacity of agro-input suppliers; form commodity-based cooperatives; train VSLA Mentor; train Farmer Group (FG) members in VSLA; link SACCOs/ progressive FGs with formal banks.
Result 1.2: Increased market accessibility
Provide FGs with Business Development Services; organize/ promote sub-county farmer markets; facilitate learning visits to model farmers/private sector actors; create added value for commodities; organize a multi-stakeholder platform and annual cross-sector dialogues; achieve progress in certification, quality control, branding and contracting.
Result 1.3: Improved nutritional status
Train VHTs/Health Workers on good nutrition practices, child health, family planning and WASH; empower cultural and religious leaders to sensitise community; increase access to prevention and curative health services; improve nutrition and sanitation practices at HH level; train VHTs on family planning, provide family planning services; conduct annual couples conference and community dialogues on family planning/GBV; conduct community dialogues for out-of-school adolescents on sexuality/ family planning, provide health services; advocate for supplies of FP commodities; facilitate debating clubs and youth peer groups in schools; collaborate with faith-based medical bureau.

Approaches

- **Holistic Family-Centered Approach:** All household members will benefit from a combination of bundled services customized to meet their specific needs, address their vulnerabilities and strengthen their capacities at the collective and the individual level and in view of reducing poverty and malnutrition.
- **Village Savings and Loan Association (VSLA) and Linkage Banking:** Provide simple savings and loan facilities in a community that does not have easy access to formal financial services. Strong VSLAs will be registered at district level and linked to formal financial institutions or federated into SACCOs for better financial inclusion.
- **Farmer Field School (FFS) with Peer-to-Peer Demonstration-based Extension Approach:** Promote practical knowledge among smallholders on improved technologies through participatory, experimental, problem solving and discovery-based learning and hence increase yields, food adequacy and

collective marketing for better market positioning.

- **Market Systems Development (MSD) and Value Chain Approach (VCA):** Make markets work for the benefit of the poor by tackling the underlying causes of market failure and strengthening the functions of market actors as well as the rules and norms that govern the market system.
- **Agro-ecology:** Apply ecological and social concepts and principles to the design and management of food and agricultural systems to optimize the interactions between plants, animals, humans and the environment while taking into consideration the social aspects that need to be addressed for a sustainable and fair food system (FAO).

Key stakeholders

Stakeholder	Role
Target farmers and their households	Main beneficiaries, participate in selection of market commodities and peer-extension agents (CBTs, Poultry Paravets, Agroecology Champions, VSLA Mentor and Market Committee Members), various capacity building activities and monitoring and learning meetings
Local Governments	Oversee implementation of activities and align the Action with the district priorities, involved from planning stage and play a major role throughout the implementation as advisors, extension workers, or beneficiaries of capacity building
Community members	(VHTs, cultural and religious leaders, senior women and male teachers, youth Mentors), contribute to changing attitudes and practices, involved at all project cycle stages.
Private sector	Expand market system and offer production inputs (seeds, tools, etc.), loans, services (market information, advisory service, quality control, vet services etc.), transport and, as traders and processors, purchase the products of target farmers and farmer groups
Advance Afrika, AFARD, Gwed-G	Local implementing partners, in charge of implementation based on a mix of geographical and technical division of responsibilities
Caritas Switzerland	Consortium coordinator and donor, ensures independent project supervision, in charge of MEL and quality assurance including capacity building of co-applicants, and the development of a network of strategic contacts with development partners
Ugandan Government	Supervising (OPM) and contracting authorities (National Authorizing Officer/ Ministry of Finance, Planning and Economic Development)
EU	Main donor

Beneficiaries total 35'900 individuals (farmers and their household members, local government officers, community and private sector members, and the staff of implementing partners).

0. Training concept

0.1. Pedagogical approach

The training is based on elements of the FFS approach and adult learning theories. The following elements are important:

- The training should be conducted in a participatory and highly interactive way because involvement and learning are enhanced when participants contribute to the discussion. It is therefore essential that participants are encouraged to share their own experiences before the theoretical material is brought to them.
- Similarly, practical exercises, where participants apply what they learn directly in a demonstration field, will enhance learning.
- The demonstration field should be located on the farm of one of the participants (host farm). All training sessions will take place in this field. The host farmer must look after the field between training sessions.
- The training plan must follow the cropping calendar for the product concerned, so that the farmer can apply what he has learned directly at home (see the proposed training calendar below). Ideally, the participants should meet every week or second week on a learning cycle comprising 8-10 meetings.
- Where appropriate, encourage participants to try different things and make small "experiments", either at home or on the demonstration field (for example, applying different types of fertilizer) and observe the effect these treatments can have on the crop.
- If possible, the facilitator should visit farmers in their fields to give them feedback on how they implement their crop at home and help them find solutions to the problems they face.

The participatory method and learning-by-doing will create a direct link between the training and the challenges farmers face when implementing new techniques at home. This will enable them to develop their observation and innovation skills and to find solutions on their own to the problems they may face. It is recommended to start each training session with the practical part, before the facilitator gives technical advice at the end of the training sessions.

Recommended structure of a training session:

1. **Welcome**
2. **A look back at what has happened since the last meeting**. (10-20 minutes)
   In the participant fields: Take a few minutes to ask participants what they have been able to apply at home since the last session and with what results. Allow participants to share their experiences with each other, highlight their successes and ask questions if they have any.
   In the demonstration field: Also take a few minutes to observe with the participants what has happened in the demonstration field since the last session. What has changed, how have the plants grown? What disease problems can be seen? Do they find insects, other organisms? How is the soil, the humidity, etc.? Facilitators can ask the participants to focus on aspects related to the topic of the day.
3. **Introduction of the topic of the day and short brainstorming to identify what the participants know already about this topic.** (10-20 minutes)
   For each chapter, some guiding questions are proposed to stimulate the discussion.
4. **Exercises in the field (2 hours).** Practical aspects of the topic of the day are directly applied in the field by the participants, with the support of the facilitator. The participants shall then apply these techniques at home as well.
5. **Summary (20-30 minutes):** the facilitator summarizes important aspects of what has been learned during the sessions and give some more technical advice if necessary.

Recommended training program

Topic	Duration	Timing
1. Introduction – importance of soybean production and choice of varieties. What is agroecology?	**1.5 hours**	4 weeks before planting time
2. Land selection and preparation (including soil fertility management)	**3-4 hours**	4 weeks before planting time
3. Planting	**3-4 hours**	Day of planting
4. Weeding,	**3 hours**	3-4 weeks after planting
5. Pests and diseases management	**2 sessions of 3 hours**	5-10 weeks after planting
6. Harvesting	**3 hours**	Week 11-20 after planting
7. Postharvest operations	**3 hours**	Week 11-20 after planting

1 Importance of soybean production and choice of varieties

A. Learning objectives

After completing this module, participants will:

- have an overview of beans production in Uganda
- understand the benefits of beans growing
- Have reflected on the reasons why they would like to grow beans
- Know the characteristics of different varieties of beans commonly grown in Uganda and be able to choose varieties adapted to the growing conditions of his farm and his production objectives
- have an idea of timing of critical activities in the beans production cycle
- Understand the principles of agroecology

B. Duration

1.5 hour

C. Learning aids

- Flip chart
- Pens
- the collaborative work on the field will be the most effective learning aid

D. Activities and exercises

Introduction (20 minutes)

The trainer will introduce the topic of the day. He may discuss the following questions with the participants:

- Why is it important for you to grow soybean? How will beans production fit within your farms? For which purpose do you want to grow soybean (self-consumption, as a source of income)?
- What could be the benefit to grow soybean?
- What could be the main problems for you to grow soybean? How to overcome these problems?

- What are the critical timing and activities of growing soybean?

Exercise choosing the right variety (30 minutes)

The facilitator gathers on a table a sample of soybean varieties available in Uganda. If possible, he also gathers different soybean plant types (erected and bush types) in pots, or pictures of them.

- Which of these varieties / plant types do you know, how do you call them?
- Which one have you already grown, eaten? Which one do you prefer and why?
- What advantages and disadvantages do you know from these varieties / plant types?
- Which ones are more adapted to agroecological production
- Which variety would you choose to grow for which purpose

The exercise can be closed by a degustation of the different varieties!

Summary by the facilitator (30-60 minutes)

- The facilitator summarizes the discussion by explaining the importance of growing soybeans.
- He may briefly present the critical stages of growing beans (see Table 1) and point out the training program, which will be following the growing cycle of soybeans, so that participant can apply directly at home the content of each training session.
- The group may also decide which variety of soybeans will be planted on the demonstration plot.
- Farm seasonal activity plan

E. Content

- Soybeans are a major food crop in the world and they are grown in some parts of Uganda and form an integral and important component in the human and animal nutrition.
- It is successful in areas where rainfall is moderate to light during the latter part of the growing season.
- There is increasing production and demand of soybeans at domestic, regional and international levels to encourage and promote soybeans production in Uganda.
- There are many varieties grown in the country, with many of them improved to suit specific requirements in the market.
- Since soybeans belong to the botanical family Leguminosae (Legumes) they play also an important role as Nitrogen fertilizer. Soyeans have the ability to transform atmospheric Nitrogen fixing it in the soil in a form that can be taken up by plants. Hence they will improve the fertility of the soil.
- They can be grown on small plots of land and are good for intercropping and as part of crop rotation.

1.1. Soybean Varieties

Currently, there are 2 major types of soybeans grown in Uganda. They include the Maksoy series and the Namsoy series.

Soybean variety selection should be based on:

i. Yield potential
ii. Maturity period
iii. Ability to stand straight
iv. Pod shattering characteristics
v. Drought tolerance
vi. Pests and disease resistance

Fig 1 Different soybean variety identification Features.

Table 1 below shows the different characteristics of released soybean varieties currently grown by farmers in Uganda. Soybean maturity and yield potential should be considered first when deciding suitability for production in an area. Early maturing soybean varieties are recommended for short term rainfall areas but it should be noted that late maturing varieties tend to yield more than early maturing varieties under standard rainfall conditions.

Table 1. Varietal Characteristics of Soybeans.

Attributes	Maksoy1N	Namsoy4M	Maksoy2N	Maksoy3N	Maksoy4N	Maksoy5N	Maksoy6N
Year of Release	2004	2004	2008	2010	2013	2013	2017
Soybean Rust Resistance	Resistant	Resistant	Tolerant	Very Tolerant	Resistant	Resistant	Resistant
Stature	Short	Tall	Tall	Tall	Tall	Tall	Tall
Lodging	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
Maturity (days)	90	100	105	100	103	96	93
Pod Shattering	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
Seed size	Small	Large	Large	Large	Large	Large	Large
Seed/ Helium Color	Cream/ Brown	Cream/ Black	Cream/ Cream	Cream/ Light Brown	Cream/ Grey	Cream/ Black with white slit	
Seed Storability	Very good	Good	Fair	Good	Good	Good	Good
Yield (Kg/ acre)	800-1,200	800-1,200	800-1,200	800-3,500	800-1,400	800-1,400	800-1,400
% Protein Content	41	43	38	36	38	38	41
% Oil Content	17	20	20	22	21	19	20

2 Land Selection and preparation for soybean growing

A. Learning objectives

After completing this module, participants will:

- Understand the factors to consider in selecting a suitable site for soybean production
- Understand how soybean plants interact with other plants and how to plan crop rotation considering spatial and temporal arrangement of soybean plants.
- Learn the best practices of land preparation for soybean production
- Know the suitable growth requirements of soybean

B. Duration

3-4 Hours

C. Learning aids

- Hoes
- Pangas
- Slashers
- Axes

D. Activities and exercises

If relevant: Look back at what has happened since the last meeting.(10-20 minutes)

Take a few minutes to ask participants what they have been able to apply at home since the last session and with what results. Allow participants to share their experiences with each other, highlight their successes and ask questions if they have any.

Introduction and practical selection of the land for the soybean plot (1 hour)

This activity should take place directly in the area where the soybean plot will be

implemented.

1. The trainer introduces the topic of the day. He then asks the participants and discuss with them the following questions, possibly directly in the area where the bean plot will be implemented:

- How would you choose an appropriate site for growing your soybeans?
- Which aspects would you look at or take into consideration?

2. Based on the discussion, the participants are asked to list the criteria on a flip chart.
3. The facilitator asks then the participants to choose the right location to implement the soybean plot and justify their choice. Alternatively, they can assess the plot that has already been selected using the criteria that have been discussed.

Exercise: preparing the land for soybean sowing (1-2 hours)

The participants, together with the facilitator, will practically prepare the land for soybean sowing.

Optional: Exercise soil fertility management and compost and manure management

- see separate leaflet Soil fertility management

Facilitator's summary (30 minutes)

The facilitator sum up important points of land selection and proper land for soybeans production based on the aspects presented in the sub-chapter" E. Content" below.

E. Content

2.1. Site Selection

Select a site with a fertile, loose, well aerated and well-drained soil for growing soybean. A good site for soybean should have good vegetation cover and gentle slopping to avoid erosion. Very stony (rocky) and extremely sandy soil sites should be avoided as these do not favor good soybean growth.

Fertile soils combined with good weather results in higher soybean yields. Loose and well aerated soils allow air to reach plant roots and nitrogen fixing root nodules. It also increases the water holding capacity of the soil and ultimately reduces soil erosion. Soybean should not be planted in extremely sandy soils or soils with excessive water.

2.2. Growth Requirements

In Uganda, soybean can be planted in two seasons. Planting in the first season is usually done in March and April while second season planting starts from August to September. Soybean production requires the following conditions:

Rainfall

Soybean requires enough rainfall from planting to pod formation. This enables fast growth and development of crop.

Altitude

Low to medium areas are suitable for soybean production. Soybean should not be grown in high land areas as these favor too much vegetative growth and formation of very few pods. In Uganda, soybeans grow well in most northern districts.

Shade

Soybean does not grow well in a shade. Farmers should avoid planting soybean in orchards, bananas and coffee plantations. The crop can however be intercropped with any cereal for example maize. If intercropping is to be done, spacing of the second crop should be increased to avoid shading. For example, if soybean is to be intercropped with maize, ten rows of soybean and one row of maize is ideal.

2.3. Intercropping

Soybeans can be cultivated both as a sole crop and in various intercropping systems with maize, cassava, sorghum, banana, sugarcane, rubber, oil palm, coconut and fruit-trees. In maize and sorghum, soybeans can be intercropped with two rows. Intercropping has many benefits, for example intercropping soybean with maize attracts parasitic wasps that control African bollworm (Helicoverpa armigera) and at the same time serves as weed cover.

2.4. Crop rotation

Soybeans should not be grown on the same site for more than two years to prevent a build-up of soil-borne diseases. Practise crop rotation of 3 to 4 years as a part of disease control. The plant grows best in a rotation after maize or small grains but should not follow edible beans, rape, or sunflowers because white mould disease can be carried over.

2.5. Land Preparation

After selecting your site, it is advisable to clear all forms of vegetation from the field. Land may be prepared by using a hand hoe, animal-drawn plough or tractor. If a tractor is used for land preparation, a single ploughing followed by harrowing is recommended for preparing a suitable soybean garden. Where hand hoe or animal drawn plough is used, primary and secondary cultivations are required to achieve a good tilth for planting.

An ideal soybean seedbed should comprise fertile loam soils that are loose and well aerated to ensure rapid germination and seedling emergence which reduces weed pressure. A fine seed bed also provides adequate moisture and optimum temperature. Farmers must avoid high clay soils since these soils are generally low in humus, are imbalanced in nutrients and act as barriers to seedling emergence.

Note: Where animal drawn ploughs or tractors are used, the garden should be ploughed across the slope to avoid accelerating soil erosion.

3 Planting

A. Learning objectives

After completing this module, participants will be able to:

- select quality seeds for planting and know the possible sources of quality seed for planting
- conduct a simple germination test
- sow beans according to the recommended practices including spacing, planting depth and seed rate

B. Duration

3-4 Hours

C. Learning aids

- Hand Hoes
- Watering cans
- Tape measure
- Planting Strings
- pegs
- Soybean seeds
- Basin
- Rhizobia
- Water
- 300 ml Soda bottle
- Sugar

D. Activities and exercises

Look back at what has happened since the last meeting.(10-20 minutes)

In the participant fields: Take a few minutes to ask participants what they have been able to apply at home since the last session and with what results. Allow

participants to share their experiences with each other, highlight their successes and ask questions if they have any.

In the demonstration field: Also take a few minutes to observe with the participants what has happened in the demonstration field since the last session. What has changed, how have the plants grown?

Introduction of the topic of the day (20 minutes)

The facilitator will shortly introduce the topic of the day and the purpose of the activity. To stimulate the discussion, the following questions can be asked:

- How would you sow your soybeans? What are recommended spacing for soybeans, recommended planting depth of soybeans, why inoculate soybean seeds before planting as well as advantages of line planting compared to broadcasting
- How would you select quality seeds?
- Where do your procure your seeds?

Demonstration germination test (30 minutes)

The trainers will show the participants how to conduct a germination test and tell them to do this at home with their seeds.

Demonstration planting soybean (2-3 hours)

Trainees will practically participate in seed sorting, seed inoculation and planting demonstration on their demo garden. This session should also be used to plant the group demo garden for uniformity of the field. The knowledge got from the demo plot practice will be used by the trainees in their fields at household level.

Summary (20 minutes)

The facilitator summarizes the main points of the topic of the day.

E. Content

3.1. Seed selection

For a good soybean production, proper attention should be given to seed quality and source.

Soybean seeds can be acquired from;

i. Local agro-input dealers.
ii. Private seed companies like Pearl Seeds, Naseco, Equator Seeds and Mukwano.
iii. Researchers or breeders such as Makerere University and Namulonge.
iv. Locally Saved seeds by farmers.

3.2. Planting of soybeans

Soybean seeds rapidly lose viability under ambient conditions. This may result in poor germination and consequently poor plant stand, which leads to considerably reduced productivity. Before planting, a farmer has only one chance to establish

the potential optimum stand by carrying out a germination test. It is always very important to test the seeds before planting to avoid waste of resources such as; time, labor and money. For soybean seeds, a germination percentage of at least 85% percent is required. If it is lower than that, either increase the seed rate or use the soybeans for something else.

How to conduct a simple germination test

The germination experiment is simple and can be done by a farmer as follows:

1. Select and prepare a suitable and well protected site around the homestead
2. Randomly select and count 100 whole soybean seeds
3. Plant the seeds in the prepared area, 10 cm from each other.
4. Water the bed every morning for 3 to 4 days
5. From day 5 after planting, count and record the number of germinated seeds
6. Do a repeat counting after another 3 to 4 days. Good viable seeds are expected to have a germination rate of over 90/100 but at least 85/100 is sufficient.
7. All the viable seeds should be able to germinate within 10 days, because germination time for most legumes is between 5 - 7 days.

Seed Inoculation

During planting it is recommended that the farmer dresses/ mixes the soybean seed with an inoculum Rhizobium Japonicum. This is a nitrogen fixing bacteria that improves on formation of root nodules and subsequently yields of soybean. Inoculation is most important in the field where soybean has never been grown.

Soybean seed Inoculation procedure/Steps.

1. Take clean water in a 300ml soda bottle, add 1-3 table spoonful of sugar and shake well to dissolve. This is used for sticking inoculum on the seeds.
2. Measure 15kgs (about 30 mugs) of Soybean seeds
3. Pour the seeds into a dry empty basin
4. Pour the prepared inoculum sticker (water mixed with sugar in the bottle) on the seeds
5. Mix the seeds well with the inoculum sticker so that the seeds are wetted.
6. Empty the MAK BIO-N-FIXER inoculant onto the wetted seeds.
7. Mix the seeds thoroughly so that all the seeds are uniformly coated with the inoculant
8. Cover the inoculated seeds with a cloth, basket or banana leaf to protect from direct sunlight. Plant the seeds immediately in a moist, well prepared field.

Plant Spacing

Spacing for soybean varies depending on planting method. If you are planting by hand, dig holes in the usual at the spacing of 50 cm between rows and 25 cm between plants in the same row way and plant 3 seeds per hole. Meanwhile, drilling by hand requires 60-cm between rows and 5-cm between plants which is best carried out by making a shallow continuous trench and covering lightly with soil.

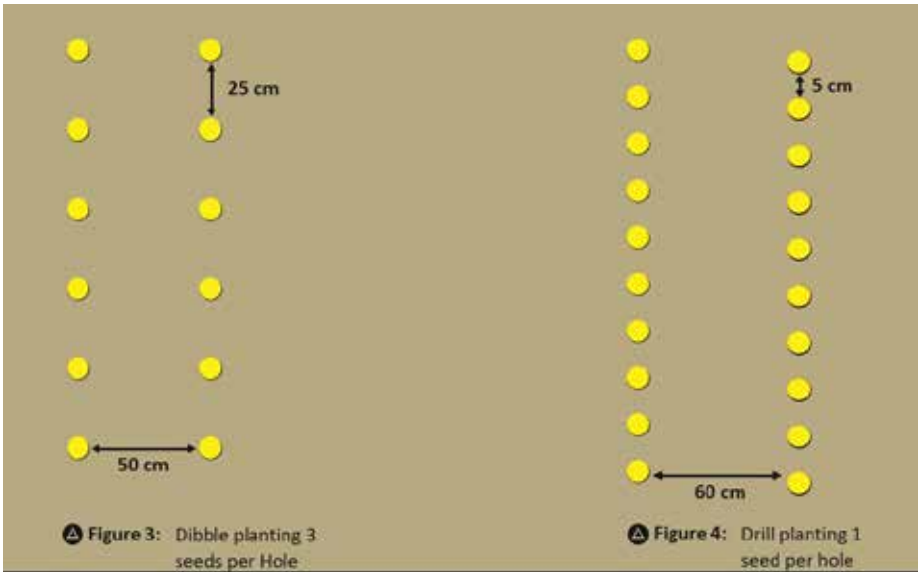

Figure 1 Correct spacing of Soybean

Seeding Depth and Germination

It is recommended for seeds to be placed at an optimum depth of 2 - 5 cm, and thereafter covered lightly with soil. Seed planted at the right depth of about 2 cm in the soil with an ideal temperature and adequate moisture, rapidly absorbs water and germinates within 2 - 3 days after planting. However, if the depth of planting is deeper than 5 cm and soil temperatures are low (not ideal), germination may slow down and Soybean emergence may be delayed for more than 6 days. After germination, it is recommended to thin the seedlings to the required within row spacing of 5 cm.

4 Weed management

A. Learning objectives

After completing this module, participants will:

- Understand the effects of weeds on the yields of soybean
- Learn the different methods of weed control in soybean
- Understand the importance of timing of weed control in soybean

B. Duration

2-3 Hours

C. Learning aids

- Hand hoes

D. Activities and exercises

Look back at what has happened since the last meeting. (10-20 minutes)

- **In the participant fields:** Take a few minutes to ask participants what they have been able to apply at home since the last session and with what results. Allow participants to share their experiences with each other, highlight their successes and ask questions if they have any.
- **In the demonstration field:** Also take a few minutes to observe with the participants what has happened in the demonstration field since the last session. What has changed, how have the plants grown?

Introduction (20 minutes)

The trainer will introduce the topic of the day. He can stimulate discussion by asking the following questions:

- Do you weed at home? How and why? If not, why?
- What is the effect of too much weeds on the soybean plants?
- What is a weed?
- Why do we carry out a weeding operation?

- What are the best practices during weeding?
- When do you weed a soybean garden for effective weed control?
- What methods of weeding can a farmer use?

Demonstration (2-3 hours)

This training should be practically done in the group demonstration field.
In a first step, the facilitator can walk through the plot with the participants and ask them to identify the weeds that can be found there.
In a second step, the participants, together with the facilitator, will do the weeding. They may not finish weeding their demo plot during this session but will do follow up weeding until the group demo is completed.
The knowledge got from the demonstration plot will be used by the trainees in their fields at household level.

Facilitator's summary (15 minutes)

The facilitator should really remind the trainees about the important of weeding since majority of the farmers tend to ignore this.

E. Content

4.1. Weed Management

Soybeans are particularly sensitive to weed competition during the first 7 weeks after planting. Weeds are a major threat to production of soybean because:

i) They compete with plants for essential growth resources like water, nutrients, light and space ultimately reducing the yield of the soybean crop.
ii) Seeds from certain weed species not only interfere with harvest operations but also reduce quality and price of grains.

Methods of weed management:

i. Hand weeding in the field. This should be done about 3 weeks after planting. The second weeding should be carried out 3 weeks after the 1st weeding. 2-3 weeding may be ideal depending on the nature of the seed bed/intensity of weeds in the garden.
ii. Although herbicides such as Round up, Weed all and Weedex can be used before planting, their use is not encouraged as prolonged use affects the environment negatively.

It should be noted that weed management starts during land preparation. Weed management should not only be done in the garden but also around the garden. It is recommended that 2 meters should be cleared around the garden. This also helps to control pests and vermin in the soybean garden.

During hand weeding:

1. Dig the weeds up exposing the roots so that they dry up and die.
2. Carry out the weeding operation before the weeds flower and set seeds so as to reduce weed population in the garden.

5 Pest and Disease Management

When: 2-10 weeks after planting

A. Learning objectives

After completing this module, participants will:

- Identify the common pests and diseases affecting soybean and their effects
- Know the signs and symptoms of different pests and disease attack in soybean
- Apply the Integrated Pest and Disease management approaches in soybean production.
- Understand the critical stages of growth of different Soybean pests to target control

B. Duration

2 sessions of 4 Hours
This topic is covered anywhere between 2-12 weeks after planting.

C. Learning aids

- Photo cards
- Demonstration garden
- Insect bottle
- Stationery
- Pressurized sprayer
- Jerrycan
- Basin
- Soap
- Pesticides

D. Activities and exercises

Look back at what has happened since the last meeting. (10-20 minutes)

- **In the participant fields:** Take a few minutes to ask participants what they have been able to apply at home since the last session and with what results.

Allow participants to share their experiences with each other, highlight their successes and ask questions if they have any.

- **In the demonstration field:** Also take a few minutes to observe with the participants what has happened in the demonstration field since the last session. What has changed, how have the plants grown?

Introduction (20 minutes)

The trainer will introduce the topic of the day pointing out what is to be learnt, including the different pests and diseases affecting soybeans and their control. The trainer should inform trainees that training will be a practical one where the trainees will be taken to the group demonstration for different pest and diseases scouting and identification.

The following questions can be used to stimulate the discussion:

- What main pest and diseases affecting soybeans do you encounter in your field
- What symptoms of pest attack and diseases have you seen on your soybeans?
- Which prevention measure do you know to avoid pest and disease attacks
- Which organic treatment against pest and diseases do you know?

Practical exercise (2 hours)

a) How to observe the bean field and the bean plant to detect pest attack and diseases?

The facilitator discusses with the participant how the field should be visited to monitor pest and diseases. Then, he discusses with them how single plants should be observed, which aspects should be looked at. An observation format could be developed by the group.

b) Practical observation of the field in subgroups

Each subgroup of 4-5 participants will observe one or two plants taking into consideration the criteria identified in a. Part of sick plants can be collected. Insects can be collected and placed in bottle. The groups summarize their observations on a flip chart and try to formulate recommendations.

c) Presentation by the subgroups in plenum and discussion

The findings of each subgroup are presented and discussed. At the end of the discussion, the mains pests and diseases found in the field should have been identified and possibilities for prevention or treatments discussed.

Summary (20 minutes)

The facilitator summarizes the main findings of the group works and discussions. He presents other important pests and diseases that may affect beans.
On other days, the groups may be doing scouting on their own and will be using the insect bottle to keep the insects and present to the Agricultural officers on the

days they visit the groups. The knowledge got from the demonstration plot will be used by the trainees in their fields at household level.

E. Content

Pest and Disease Management

Soybean is affected by many pests and diseases that occur over a wide range of conditions and plant growth stages. Accurate identification of pathogen species is very difficult if the infected plants are already dead which calls for regular field visits so as to enable the farmer detect signs and symptoms early enough.

The first step towards pest and disease management is by using seeds free from pests and disease causing and organisms.

Pests

1. **Webworms (Leaf Miners)**

   These cause blister like mines on leaves (midrib) cutting water and nutrient flow to and from the leaves. The damaged leaves become brownish, rolled and eventually dry up leading to early leaf fall which reduces effective leaf area for photosynthesis.

   Alternatively, use ash brew to manage the webworm, at a rate of 3%; that is 600mls of the concentrated ash brew diluted in 20 l of water. Preferably spray very early in the morning or evening when atmospheric temperatures are low.

2. **Soybean leaf beetles**

   The soybean leaf beetle can be confused with some other spotted beetles found in soybean e.g. the lady bud beetle. The beetles are important immediately from seedling emergence until the first trifoliate leaf has unrolled and later during pod filling. They cause leaf defoliation and stand reduction but the greatest economic damage occurs when the beetles feed on the developing pods. It can also transmit the soybean mottle mosaic virus.

Control

Depending on the severity of attack, the beetles may be controlled by available pesticides on the market.
Intercrop with repellants, like American marigold, design the field reduce the pest incidences.

3. **Stink bug**

   Stink bugs are important soybean pests in Uganda which pierce the pod pericarp and suck the milk sap from the developing seeds. This causes seeds not to develop and at times causes dropping of pods. The plant

compensates for lost pods by setting new ones but infested pods have fewer and smaller seeds. When pods are damaged severely by stink bugs, the soybean plants retain their leaves, while stems remain green long after normal maturity period. Green stems among mature plants ready for harvest make harvesting difficult.

Control.

Spray with Dimethoate, Striker or Rocket

Alternatively apply ash brew, at least once every week (7 days), create barrier around the field, and plan effective crop rotation.

Diseases

Different diseases attack soybean crops at different times during the crop growth stage.

Depending on moisture and temperature conditions, seedlings are more susceptible to three major diseases

i) seed rots prior to germination,
ii) seedling decays between germination and emergence, and
iii) damping off during the first 2- to 3-weeks after emergence.

Leaf Diseases

1. Soybean rust

Fig. 1and 2. Soybean rust symptoms on the upper and lower side of leaf respectively.

This is caused by a fungus. The symptoms of soybean rust include small-water soaked lesions on underside of leaves, blister-like matter with a central pore on the lower side of the leaf. Lesions gradually increase in size and later turn from gray to tan, reddish-brown or dark brown and assume a polygonal shape but are restricted by leaf veins.

Control

Spray with lactic acid bacteria (LAB), twice a week before flowering. Dilute at the rate of 20 milliters of LAB in 20 Liters of water.

2. Bacterial blight


Fig3. And Fig 4. Photographs showing signs of bacterial blight on a Soybean leaf.

3. Bacterial pustule

Infected plants display small, pale, yellowish green lesions with dark reddish-brown centers which are mostly conspicuous on the upper leaf surfaces. The central part of each lesion develops into a very small, raised, light-colored pustule on the abaxial (lower) leaf surface.

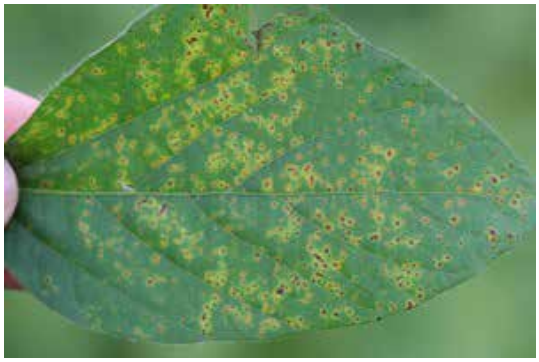


Fig5,6 Bacterial Pustule on Upper and Lower sides of a Soybean leaf.

Control

Apply LAB at an early stage of plant development to boost the health of the plant. Note: spray above and underside of the leaf; dilution 20 mls of LAB in 20 liters of water (use spring water, borehole water or rain water, do not use chlorinated water. Apply a well prepared plant tea/(biofertilizer) at an early stage of plant development. Apply lime sulphurs for plant nutrition correction at a rate of 3% twice in 7 days before flowering; note: do not apply during flowering stage.

Disease Management

Although soybean diseases have increased in Uganda, the available varieties are resistant to most of them. Soybean rust disease is the most devastating and prevalent in Uganda. However, resistant varieties have been bred and developed. Therefore, the most recommended control measure of soybean diseases is the use of resistant varieties like Namsoy 4M, Maksoy 1N, Maksoy 2N, Maksoy 3N, Maksoy 4N, Maksoy 5N and Maksoy 6N. However, fungicides can be used to control soybean rust if susceptible varieties (NAM 1 and NAM 2) have been planted.
The readily available fungicides in agro-input shops include:

a). Diathane M45. Its mode of action is protectant and active ingredient is Mancozeb. The rate of application: 2.5 g/liter of water or 1 leveled teaspoon in two liters of water. Best results are obtained when applied at 2 weeks intervals from disease onset that is, when rust spots first appear on lower leaves.

b). Saprol. Its mode of action is systemic and active ingredient is Triforine. Rate of application: 1.6 Kg/ha (2 ml / liter). Should be sprayed at 2 weeks intervals from disease onset that is when rust spots first appear on lower leaves.

c). Folicur. Active ingredient is Tebuconazole. Its Mode of action is systemic. It is both a protectant and curative fungicide. Rate of application: 830 mls / ha (1 ml /liter). Should be sprayed at 3 weeks intervals from disease onset that is when rust spots first appear on lower leaves.

However, the use of this fungicides are not recommended in agroecological production

6 Harvesting

A. Learning objectives

After completing this module, Participants will:

- Identify signs of maturity and ripening in the soybean
- Understand the correct stage of Soybean crop harvesting
- Learn the different methods and practices of harvesting soybean

B. Duration

3-4 Hours

C. Learning aids

- Hand hoes
- Sickles
- Tarpaulin
- Bags

D. Activities and exercises

Look back at what has happened since the last meeting. (10-20 minutes)

- **In the participant fields:** Take a few minutes to ask participants what they have been able to apply at home since the last session and with what results. Allow participants to share their experiences with each other, highlight their successes and ask questions if they have any.
- **In the demonstration field:** Also take a few minutes to observe with the participants what has happened in the demonstration field since the last session. What has changed, how have the plants grown?

Introduction (20 minutes)

The trainer will introduce the topic and ask the following questions to stimulate the discussion:

- What are signs of maturity in the soybean crop?

- What is the correct stage of harvesting? When do you harvest your soybeans?
- What post-harvest handling operations do you apply?
- What are the common mistakes made by farmers during harvesting of soybeans?

This can be directly in the field, so that participants can look at sign of maturities directly on the crop.

Demonstration (2 hours)

The participants, together with the facilitator, will harvest the soybeans. This training should be done at the demonstration sites so that the farmers learn good harvesting practices and replicate in their fields at household levels.

E. Content

6.1. Maturity indicators in Soybeans

At maturity, the soybean pods turn from green to yellow then golden or brown color. The soybean leaves also fall off at this time. These changes should happen between the 13-15 weeks after planting.

6.2. Harvesting

Harvesting is the last important operation to be considered for the production of good quality seed and grain. Most soybean varieties are harvested within a period of 90 - 120 days or 13-15 weeks (3-4 months) after planting. Timely harvesting of soybeans minimizes seed quality reduction in the field, infestation by insects and losses from physical damage. It is therefore important for the farmer to keep records of the planting date. It is recommended that soybean be harvested when the pods make a rattling sound when shaken. Harvesting can be done with a cutlass, a hoe, or sickle. Please note that delayed harvesting may cause the pods to start shattering in varieties that shatter leading to yield loss. Soybeans should be harvested as soon as the plants have dried.

6.3. Harvesting Methods

Hand harvesting

This is suitable for small land areas, where labor readily available. The advantage of this method is that losses can be kept at a minimum, soybeans of a high quality are produced and the seeds are normally of a high viability. Therefore hand harvesting is suitable for seed production. The usual practice of hand harvesting is to allow laborers to cut or pull as much plant material as they are able to thresh in a day. Do not harvest by hand pulling because this removes soil nutrients leading to soil deterioration. Rather, cut mature soybean plants at ground level so as to leave the root nodules underground and help to retain nutrients fixed in the soil.

Figure 14 Soybean harvesting practices

7 Post-Harvest Handling

A. Learning objectives

At the end of this session, the learners will:

- Know the different activities recommended after harvesting soybeans
- Learn the different methods and practices of threshing, cleaning and drying soybeans
- Identify and minimize different post-harvest losses in soybean
- Know the correct storage practices of soybean

B. Duration

4 Hours

C. Learning aids

- Tarpaulins
- Bags
- Pallets

D. Activities and exercises

Look back at what has happened since the last meeting. (10-20 minutes)

- **In the participant fields:** Take a few minutes to ask participants what they have been able to apply at home since the last session and with what results. Allow participants to share their experiences with each other, highlight their successes and ask questions if they have any.
- **In the demonstration field:** Also take a few minutes to observe with the participants what has happened in the demonstration field since the last session. What has changed, how have the plants grown?

Introduction (30 minutes)

The facilitator will introduce the topic of the day and guide the participants to understand by asking questions including:

- What post-harvest handling operations do you apply?
- What are the common mistakes made by farmers during harvesting of beans? What problems do you encounter during postharvest?
- Why is it important to carry out good post-harvest handling?
- What are the recommended post-harvest handling practices? How do we enhance grain quality?

Demonstration (40 mins)

This session is to be done at the Demo host's home and the trainees will practically participate in Drying, Threshing, Winnowing, Bagging and storage of the soybean grains. The knowledge got from the demo practice will be used by the trainees in their individual homes.

E. Content

Post-harvest handling is the major activity carried out after harvesting. It is important that farmers perform these operations with care not to cause losses in quality and quantity of grains. This activity is performed between 13-20 weeks after planting of the soybean crop.

7.1. Drying

Natural drying is done by the normal movement of ambient air around the moist seed spread either on a mat, plastic sheet, tarpaulin or clean cemented drying yard after harvesting. Soybean can also be dried on a raised platform or in a crib.

Figure 15 Good practice: Farmer drying the soybeans on a tarpaulin in the sun.

7.2. Threshing

Threshing soybean can be done by a stick. Threshing should be done on a cemented ground or ground smeared with cow dung although it should be noted that threshing soybean on bare ground leads to poor quality grain with a lot of stones and soil. Also, care should be taken during threshing to avoid grain loss and damage.

It is a better threshing practice to use a threshing rack which protects the seed from damage and dirt and prevents it from scattering. The threshing rack consists of strips of wood arranged in a platform with a wire mesh tray at the bottom to catch threshed seeds. It has high wooden sides which prevent the seed from scattering. A threshing rack can easily be made by a local carpenter.

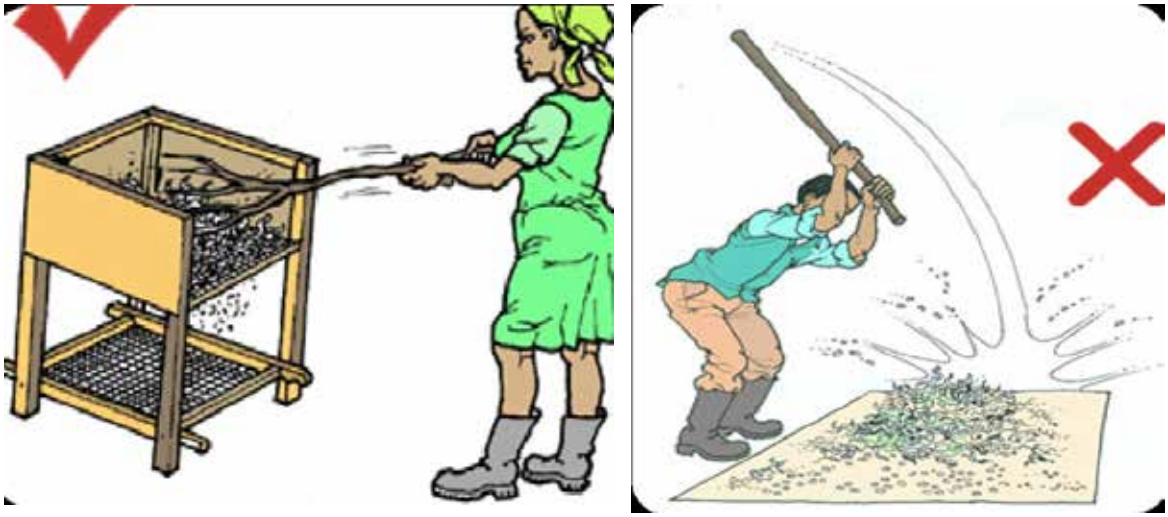

Figure 16 Cage threshing of soybeans (left) and threshing on open tarpaulins leading to seed loss (right)

7.3. Winnowing and sorting

This is important to separate soybean seeds from debris/chaff. After winnowing, the soy bean seeds should be sorted and graded, ensuring that damaged, shriveled, and small seeds are removed to ensure uniformity.

Figure 17 Farmer is winnowing the threshed soybeans

7.4. Drying of Soybean Seeds.

After threshing and winnowing, dry the soybean seeds on a mat, tarpaulin or platform to avoid soiling and contamination. Drying of seed should not be done at high temperatures because this adversely affects the quality and reduces viability. Proper drying of seed reduces storage losses. To ensure that there is sufficient drying, test the soybean grain to see whether it is dry enough by biting. If the grain is dry, it will make a cracking sound. If they are still soft, dry them a little further. Soybean should not be left under the rain during the process of drying as it reduces the quality of the grain and may lead to rotting of the grains.

Figure 18 Drying of threshed Soybeans on tarpaulins (left) and testing for proper drying (right)

7.5. Storage

During this stage, seed should be graded and differentiated according to variety and quality. Also, remove all impurities, including foreign matter and weed seeds. After the seed has been cleaned, it should be weighed and packed. Seed should be dry before storage so that its viability can be maintained during the storage period. Soybean should be stored at a moisture content of 10 - 12%. Seed is sufficiently dry when it cannot be dented with the teeth or fingernails. Dry to about 12% moisture for storage of 6–12 months and to about 10–11% for longer storage. If seed is stored with high moisture, it will accumulate heat and rapidly deteriorate. The seed should be stored on raised platforms, in a dry cool place with bags neatly stacked on each other and adequate space of at least 1 m left on the sides and between the last layer of bags and the roof.

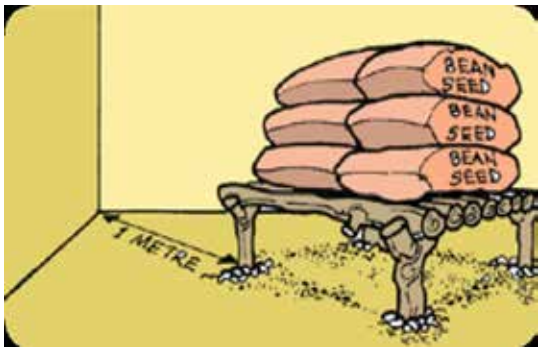

Figure 19 Good practice: neatly stacked bags of bean seed with adequate space on the sides.)